Providing Consumers with Sale Information: Evidence from a Field Experiment in Online Supermarket Shopping.*

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August 18, 2019

Abstract

Does providing consumers with information about discounts help them realize more savings? We address this question using data from a field experiment on a website for online grocery shopping. Our results illustrate the difficulty in using information provision to steer shoppers towards cheaper alternatives (of equal or higher quality than their substitutes). We find that providing (treatment) shoppers with promotional information on sale categories increases the probability of purchasing within the category. This effect is driven by an increase in purchasing rates for both the reduced priced items and *regularly priced substitutes*. Our analysis focuses on understanding how item placement, promotional information, and the way retailers display promotional information impact consumer choices in a multi-product environment where prices are changing.

Keywords: Limited attention, Salience, Information processing, Supermarket shopping.

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*Financial support from the The Pinhas Sapir Center for Development at Tel-Aviv University and the Michigan Institute for Teaching and Research in Economics is gratefully acknowledged. We are in debt to Benny Wang for his tremendous help with this project.

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1 Introduction

A consumer in the modern marketplace is faced with an overwhelming amount of information about a multitude of consumption alternatives. There is an ocean of substitutes for almost every product type, each product type is offered by myriad suppliers, and there are frequent promotions that cause prices across suppliers to fluctuate continuously. Since consumers may have only a limited amount of time to devote to price comparisons, they may end up missing bargains that can help them save money. This raises the following question: If consumers are provided with information on sales, will they be more likely to purchase the discounted items? More generally, how does information on discounts affect consumers' search for the best deal? Addressing these questions can improve our understanding of how promotional information affects demand. The answer is important for both policymakers interested in helping consumers realize potential savings, and for retailers interested in using discounts to steer consumers to particular items.

To tackle these questions, we analyzed data from a series of randomized controlled trials conducted by a website for online grocery shopping. During a three-month period the website offered discounts on a subset of the items it sold, such that each month, a different set of items was discounted (prior to the period of the experiment, the website did not offer any discounts and all prices were kept fixed). The discounted items were selected such that each had an obvious, more expensive substitute of equal or lower perceived quality (e.g., organic fruits were priced the same or lower than their conventional counterparts). In addition, during each week of the trial period, the website also offered an immediate rebate (given at checkout) for buying at least one unit from a certain category. Shoppers were randomly allocated to a treatment and control group. All shoppers received weekly promotional emails announcing the items that were eligible for a rebate that week. But the email to the treatment shoppers also included information on the discounted items. Specifically, they were informed that some items were discounted and provided with a list of food categories with the biggest discounts in percentages (in the first three weeks, categories were listed in descending order of discount size, and afterwards in ascending order of discounts). Shoppers in the control group received no information on discounts.[1]

[1] As we explain in Section 3, the discounts were not promoted on the website. Rather, discounted items were marked by small asterisks. Thus, a shopper who did not know that there were discounts (and from his prior experience with the website, did not expect any discounts), could easily miss

We aim to understand how information provision impacts the likelihood of choosing the discounted item over its more expensive substitute, and how this likelihood is affected by product display (whether a discounted item appears next to its substitute) and the amount of information provided (e.g., listing categories of items with the largest discounts versus adding more detailed information on the types of items on sale).

Our analysis provides a number of key observations. While some of these observations are intuitive, our study permits us to quantify their magnitudes and their effect on savings.

Informing shoppers that some items are on sale may increase the demand for the non-discounted substitutes of those items. Notifying shoppers of food categories with discounts increases their probability of making a purchase within these categories by roughly 200 percent relative to the control group (an increase of 1.6 percentage points (s.e. 0.6) at an average purchase rate of 0.8 percent (s.d. 9)).[2] During each week of the experiment, discounts were offered in roughly thirteen food categories, such that shoppers could save a total of $11 if they switched to each discounted item from its more expensive substitute in every category. The benefit of the sale averaged $4, as 70 percent of the increase in purchases made by treatment shoppers was due to an increase in the purchase rate of the *more expensive* substitute item.

Even with the ease of online shopping, searching for substitutes is costly, and the likelihood of realizing savings from discounts decreases with search costs. A unique feature of our data is that we observe the spatial display of items on shoppers' screens. In particular, we know which substitutes are displayed next to each other and which require scrolling down.[3] This enables us to obtain a partial ranking of the costs entailed in comparing the prices of substitutes: The cost of comparing the prices of X and Y is higher than that of comparing the prices of Z and W, if Z and W are displayed next to each other while X and Y are not.[4]

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the asterisks. But all shoppers saw the same prices.

[2]Specifically, treatment shoppers were notified of the four categories with the biggest sales, as well as the largest discount (in percentage terms) within each of these categories.

[3]The display of items on the screen was determined by the developer and remained constant throughout the experiment. Whether a pair of substitutes are displayed next to each other is independent of their prices, or of the difference between their prices. Buying a substitute item was on average 28 percent more expensive than the on-sale target item for non-neighboring items, and 25 percent more expensive than the on-sale target item for neighboring items.

[4]The relative display of items–i.e., whether items are adjacent or not–remains true whether the

Indeed, we find that the likelihood of buying a discounted item (of marginally higher quality) versus its substitute *increases* by up to 26 percentage points (s.e. 8.3) when the discounted item and its substitute appear *adjacent* on the screen compared to 14 percentage points (s.e. 4.9) when they are located farther apart. On average, purchasing a discounted item versus its substitute resulted in savings of \$0.88 relative to the non-discount price (which averaged \$2.99). This means that displaying substitutes next to each other (which does not require shoppers to search for the different substitutes of a particular product) can lead to a 12 percent increase in choosing the cheaper item, resulting in an average \$0.11 in savings per on-sale item across shoppers. It is important to keep in mind that the average American supermarket carries close to 40,000 items, so that even if only one percent of these items are on sale, the placement of these items could result in significant changes to consumer surplus.[5]

Salience matters: Shoppers are more inclined to purchase items in the sales category that is listed first, even if the categories are listed in ascending order of discounts. The largest difference between the treatment and control groups is observed for items in the discounted food category that was listed *first* in the treatment email. During most weeks, the top listed category consisted of items with the *smallest* discounts, and while control shoppers were *less* likely to purchase discounted items in this category, treatment shoppers were *more* likely to do so. Thus, the difference in purchasing rates between the treatment and control group is driven by the first item category, with treatment shoppers increasing their purchase rate of the discounted item by 1.8 percentage points (s.e. 0.8) more than the control group.

Precision matters: Shoppers are less inclined to purchase non-discounted substitutes of the on-sale items during weeks where they received more precise information on sales. During weeks when treatment shoppers received emails alerting them of the top discounted food categories (which include both on-sale organic items and regularly priced substitutes) they increased their purchase rate of the regularly priced substitutes by 1.5 percentage points (s.e. 0.6). This sale response on the regular priced substitutes shrinks to 0.2 percentage points (s.e. 0.5) when the email to the treatment group precisely noted that organic items were on sale alongside a person-

shopper uses a computer or a mobile device.

[5] The Food Marketing Institute, a trade group, reported that the average number of items carried in an American supermarket in 2016 was 38,900.

alized nudge to consider cheaper alternatives in categories where treatment group consumers had previously purchased the conventional alternative.

The above observations suggest that search-costs introduce frictions that may prevent shoppers from realizing savings opportunities even when they are notified of these opportunities. In particular, coarse information - specifying only the product categories with the biggest sales - can also lead to higher purchases of the items that are *not* on sale. To formalize these ideas and illustrate a mechanism that can generate our observations, we propose a simple stylized model that has the following ingredients.

A shopper initiates a shopping trip when she realizes that she needs to restock some set of products. But she may not remember if some product type needs restocking or not. A promotion announcing a sale in a particular product category serves as a signal that reminds the shopper that she needs to buy in that category. But if the announcement is sufficiently coarse (i.e., it does not specify the exact items that are discounted), the shopper may decide to save on search costs and look only for the brand that, according to her prior belief, is cheaper. Consequently, information on discounts in a product category can increase the demand of non-discounted brands in that category.

The remainder of the paper is organized as follows: Section 2 discusses related literature; Section 3 explains the design of the randomized control trials; Section 4 provides summary statistics on the sample; and Section 5 discusses the results. In Section 6, we present a simple model. Section 7 discusses the responses to a post-experiment survey regarding consumer preferences. Section 8 concludes.

2 Related literature

Our paper is related to several strands of literature involving theoretical, experimental and empirical work. The theoretical literature both motivates our study and supplies possible mechanisms for some of the regularities we observe in the data. One source of motivation is the recent studies on the effect of *salience* on consumer behavior. Most notably, Bordalo, Gennaioli and Shleifer (2016) propose a model of how one product attribute may be more salient than another. In our data, salience plays a role in terms of which discounts are more prominent (e.g., appear on the same line on the computer screen). A second source of motivation is theoretical work, such

as De Clippel, Eliaz and Rozen (2014), that studies how consumers allocate limited attention across many products with changing prices. In addition, Ke and Lin (2018) propose a model that, in equilibrium, generates the effect that a price decrease of one brand can increase the demand of another brand. This is relevant to our paper since we observe that a price cut of one product can increase the demand of an alternative product that is not on sale. The key ingredients in Ke and Lin's (2018) model that generate this effect are (1) the fact that competing brands share common features, and (2) consumers are uncertain about the values of these features and try to learn about them.

Several studies provide experimental evidence on how individuals manage limited attention. Gabaix, Laibson, Moloche and Weinberg (2006) provide evidence that laboratory behavior of subjects in experiments where instrumental information was costly to acquire (either financially or because time was scarce) matches the predictions of a boundedly rational model where individuals use only approximate option-value calculations. Caplin and Dean (2013) use a laboratory design to test a behavioral property of the rational inattention model. In contrast to our work, these studies have been performed on students in laboratory settings. A recent exception is Bartos, Bauer, Chytilová and Majtěka (2016), who provide evidence from field experiments in rental housing and job applications showing that suppliers in these markets do not acquire all the available information (they do not view the resumes of all the applicants), but rather focus their attention only on a select group of applicants, based on stereotypical attributes of that group.

Since there are many empirical works, both on supermarket shopping and on the effect of promotions and sales, in this review we focus only on those studies that directly deal with either limited attention or with online promotions. With regards to limited attention, several recent papers present empirical evidence on its implications on consumer behavior. One line of inquiry investigated the impact of making associated fees salient to consumers. Hossain and Morgan (2006) conduct a field experiment on eBay and found that when two auctions offer the same effective total price, more bidders are attracted to the auction with a lower opening price and higher shipping price. Chetty, Looney and Kroft (2009) provide evidence from a field experiment in a grocery store showing that posting prices that include taxes reduces demand. Blake, Moshary, Sweeney and Tadelis (2017) use data from a field experiment carried out by an online retailer to show that up-front display of the

total cost of each available item, including all fees, (as opposed to displaying only the listed prices and adding the fees at check out) affects not only the likelihood of purchase but also the quality of the items purchased.

A second strand of literature focused on the extent to which consumers search for the best prices. De los Santos, Hortacsu, and Wildenbeest (2012) use a large dataset on web browsing and purchasing behavior to test whether consumers are searching in accordance to various classical search models. Helmers, Krishnan and Patnam (2015) use a unique data set from an online retailer to show that consumers are more likely to buy products that receive a saliency shock when they are recommended by new products.[6] Bronnenberg, Dubé, and Sanders (forthcoming) run a field experiment where treatment shoppers participate in a blind taste test comparing private labels to national brands. They find that a majority of shoppers prefer the private label (cheaper) products and document a large demand increase for the week following the intervention. Clerides and Courty (2017) use scanner data from a supermarket chain to show that during periods in which the price of a discounted pack of detergent was lower than the corresponding price of a larger ("economy size") pack (of the same product), consumers still bought the larger, and more expensive, pack. This suggests that some consumers are either not comparing all prices, or are not computing (or computing erroneously) the price per unit when making their purchasing decisions.

Our study adds to the existing literature by examining how consumers' shopping decisions are affected by the relative prices of substitute goods and how different levels of information provisions affect these choices. The experimental design sheds new light on the difficulty consumers face in allocating their attention and in making optimal choices even when the information is readily available on a single webpage. Importantly, as supermarket shopping involves repeat purchases of goods over short time periods, we can verify the robustness of our results when examining the same individual making choices over time concerning the same products at varying prices.

The main obstacle in conducting an empirical analysis of limited attention is the difficulty in obtaining data on the information to which consumers paid attention. Abaluck and Adams (2018) propose an innovative approach to overcome this challenge. In a random utility framework, they identify sufficient conditions on preferences and on the products' attributes that enable identification of choice and

[6] The salience shock was created by a group of items that appeared below each product with the title "You May Also Like."

consideration probabilities from differences in cross derivatives of the choice probabilities with respect to product attributes. The key insight is that under limited attention these cross derivatives exhibit an asymmetry, which can be exploited for the identification exercise. We take a different approach to overcoming the challenge of obtaining data on what consumers know: We conduct a field experiment that directly manipulates the information provided to shoppers.

One of our main findings is that promotional emails offering discounts on some items increase the sales of similar items that were not on sale. A similar effect was reported in Sahni, Zou and Chintagunta (2017). They observed that when a website selling tickets to sporting events offered discounted tickets to some events, its revenues increased, but only a small proportion of this rise came from the sale of the discounted tickets. The authors interpret this finding as suggesting that promotional emails divert attention to the promoting firm (i.e., the website) and this may have increased the traffic to it. In our experiment, discounts offered on items in a particular food category may have diverted attention to that category (e.g., reminded shoppers that they need to buy items in that category). This may have resulted in more purchases of non-discounted items because these were the products shoppers had purchased in the past (the more expensive discounted items made up only 23 percent of in-category purchases prior to the experiment). Dubé, Hitsch, and Rossi (2010) also documented inertia in brand choices when examining supermarket purchases of orange juice and margarine. But while they rule out a search cost explanation and attribute their results to brand loyalty, we present evidence that product inertia is strongest for items that did not appear next to their discounted alternatives.

3 Experimental design

The platform. We partnered with a website that offers a purchase and next-day delivery service from a large American supermarket in a university city. The website includes roughly 3,000 items that are sold in the supermarket store. These items are divided into several sections to help shoppers perform an intuitive search (e.g., produce, dairy, etc.). Shoppers need to add the items that they would like to purchase to their basket, and at checkout they pay for the products, plus a flat delivery fee of $2.99 for each order. During the period of the experiment there was no option to re-order previous baskets or to add items from previous orders. Additionally, all

prices were fixed and there were no promotional sales. Shoppers are required to choose a delivery date and a two-hour delivery window. The cutoff time for next day delivery is midnight every day. These shoppers are mainly students (80 percent) with some professors (10 percent). Only 10 percent of shoppers are unaffiliated with the university.[7]

The website was interested in encouraging its registered customers to increase the frequency and volume of their purchases, and to learn how different promotional tactics affect shopping behavior. To achieve this goal, they planned to conduct a series of randomized controlled trials. They agreed to allow us to influence the design of these trials in a way that would also enable us to address our questions. Hence, the experimental design was somewhat constrained by the objectives of the website.

Temporary discounts. The experiment was conducted over a period of thirteen weeks during which the website offered temporary discounts so that the prices of some select items fluctuated, dropping during the sale and rising when the sale expired. Discounted items were marked on the website with two asterisks (**), and a footnote at the bottom of the screen explained that the marked item was on sale and specified the original higher price. The website used this method of marking discounts because of the following: First, we did not want discounts to be too salient so there would be an advantage to receiving an email that provided information on which items were discounted; Second, we wanted to allow any shopper who accessed the website to find out about the temporary sale if she exerted some effort in noticing fine details.[8]

The experiment focused on items in twenty-eight product categories that were popular with shoppers in the pre-experiment period (see Table 1).[9] Each of these product categories (e.g. milk, tomatoes, water, etc.) included at least two items that could be considered substitutes. Each month a different set of categories were discounted so that a discount on an item was valid for one month. The items whose prices were manipulated during the experiment are defined as *target items*, and their

[7] This information was obtained from responses to an optional survey conducted at checkout during the first month of the experiment period. Eighty percent of the shoppers who made a purchase during the experiment period responded to the survey.

[8] We operated under the constraint that all shoppers must face the same exact set of prices.

[9] The twenty-eight product categories are: bananas, kiwis, lemons, raspberries, apples, bulk apples, blueberries, pineapples, avocados, broccoli, cucumbers, kale, onions, green onions, peppers, lettuce, limes, tomatoes, bread, organic bread, eggs, brown eggs, organic eggs, milk, bulk milk, organic milk, yogurt, and water.

alternatives are defined as *substitute items*. During the period with the lowest relative discounts (in percentages) on target items, the highest discount was 25 percent, while during the period with the highest relative discounts, the maximal discount was 75 percent. See Tables 2 and 3 for a full list of the relevant target and substitute items as well as the discounts given during the experiment period. The discounts were set so that the on-sale *target item* would be priced either the same or below the price of the *substitute item*.

The discounted target items fell into four general categories: (i) organic and conventional items, (ii) same items that are offered in different sizes (e.g., jumbo avocado and regular avocado) or bulk quantities (e.g., apples that are offered as single units or in 3-lb bags, or milk that is offered in 0.5 gal and 1 gal containers) (iii) brand names versus generic store brand (e.g., Aunt Millie's breads versus generic supermarket whole wheat bread), and (iv) two competing brands of the same exact product (e.g., Dasani vs. Ice Mountain mineral water in bottles of the same size).

There are two motivating factors behind the choice of target items. First, we tried to select target items that had "almost perfect" substitutes and which had low levels of brand loyalty. Recent evidence suggests that consumers display relatively low brand loyalty to supermarket items as compared to clothing and appliances (Nielsen (2013)), and their choice of food brands is most affected by price considerations (Byron (2008)). Within the food and beverage category, consumers tend to exhibit more brand loyalty to breakfast cereals, carbonated drinks, and snacks (Chidmi and Lopez (2007), Nielsen (2013)). *None* of these were included as target items in the experiment, hence, we assume that price sensitivity is stronger than brand loyalty in deciding between a target item and its substitute.[10]

The second motivating factor is the public perception of organic items. Studies have indicated that consumers generally express positive attitudes toward organic foods, perceiving them as tastier and kinder to the environment (Roddy et al. (1996); Magnusson et al. (2001); Perkovic and Orquin (2017)). While there may be disagreement among researchers about whether this perception is backed by scientific evidence (see Baransky et al. (2014) for a meta-analysis that claims there are healthier

[10]In a post-study questionnaire of the participants, 80 percent of 55 individuals who responded answered that they would switch brands for a discount of 20 percent. We found a similar response when surveying an additional 378 US respondents in the same age and education categories. See Section 6 for more detail.

aspects of organic food), what is important for this study is public perception.[11]

An important feature of the discounted items was the variation in their display: Some close substitutes (where one was discounted and the other was not) appeared next to each other on the screen, while others appeared in different rows and required scrolling down to notice both items. Whether a target item and its substitute appeared on the same row was independent of their prices relative to other products. We will use the variation in location as a proxy for the cost involved in comparing the price of a target item with its substitutes.

Rebates. In weekly emails, shoppers were offered an immediate rebate (applied at checkout) if they spent at least $20 and also bought at least one unit of an item from a given group of eligible items (which changed every week). During the first three weeks of the study, the rebate was equal to the flat delivery fee of $2.99 (it was presented to shoppers as free delivery), and in the last three weeks it was raised to $10.[12] Between the fourth and the tenth week, the rebate was $2.99 for the control group and $10 for the treatment group (the difference between these two groups is explained below). Table 4 lists the rebate category offer for each week as well as the prices of the target item and substitute item in the category alongside the benefit of purchase for individuals in both the treatment and control groups.

Treatment and control. The 355 shoppers who made purchases in the second half of 2015 were randomly divided into two groups—178 in treatment and 177 in control.[13] Treatment shoppers received additional information on discounted items in the weekly email. In order to separately measure the effect of the email contents from a general salience effect or compliance effect, both groups were sent weekly promotional emails with information on the rebate category.[14] But during the en-

[11] In our post-study questionnaire, 91 percent of 55 responders said they would buy an organic item if its price was weakly cheaper than a conventional version of the same item. This result also held in an additional survey follow-up with 378 participants. See Section 6.

[12] Starting with free delivery before moving to the high rebate was also intended to give credibility to the promotional offer.

[13] While we have data on shoppers beginning in December 2014 (over a year before we ran the experiment) we only include shoppers who had made a purchase within the previous six months when defining the treatment and control groups. We expected these shoppers to be the most likely to make purchases during the period of the experiment.

[14] As noted above, for roughly half of the experiment both the treatment and control emails provided the same rebate amount when buying an item in the rebate category. The observed differential effect of the sale on the treatment and control group is robust to running the analysis only on the same rebate weeks as well as including a control for rebate size in our analysis when including all weeks.

tire period of the study, the email to the control group did not mention any price discounts.

In contrast, the email to the treatment group displayed the following: four product categories (e.g., milk, eggs, fruits, bread) that were on (temporary) sale that month; the biggest discount available in each of the categories (expressed in percentage points); and a link to the relevant page of each category. The treatment group was also informed that discounted items were marked by "**".

During the second half of the study (from the sixth week on), shoppers in the treatment group began to receive a more detailed weekly email. For these weeks, the email alerted shoppers that many organic items were now on sale and even cheaper than non-organic items. Additionally, those who had purchased a substitute item in a category that was now on sale received a personalized email alerting them to this fact (e.g., "Don't forget to consider some alternatives to your last purchase of eggs that we have on sale this month"). Figures (1) and (2) depict examples of the email formats for both the treatment and control group.

4 The Data

This paper analyzes purchasing decisions made by 355 shoppers over the thirteen weeks of the experiment in 28 product categories (see footnote 9). 177 shoppers were assigned to control, and 178 to treatment. For each of these 355 shoppers, we tracked their decision of whether to make a purchase in each category over the duration of the experiment (129,220 observations). In total, 130 shoppers made 1,046 category purchases over 338 shopping trips during the experiment period. 66 shoppers made 167 shopping trips in the control group, and 64 shoppers made 171 shopping trips in the treatment group.

Table 5 provides summary statistics in the pre-experiment period (December 2014 - January 2016) for both the full sample and a subset of 305 shoppers who had a history of purchasing in at least one of the 28 product categories (152 in control and 153 in treatment). This subset is important as it turns out that past purchases within the product category are a very strong predictor of current purchases with differential effects between those allocated to the control and treatment groups. Not surprisingly, since individuals were randomly allocated to treatment and control, there are no significant differences in shopping trends between the treatment and

control groups during the pre-experiment period. Generally, shoppers had shopped on the site five times prior to the experiment, with trips averaging roughly $70. Importantly, when conditioning on shoppers who made purchases of either the target or substitute items, the control and treatment groups continue to look very similar. In the pre-experiment period, the substitute items were generally purchased far more frequently than the target items by all shoppers.

Recall that when a shopper browses through items, some discounted target items are displayed right next to their substitutes (or in the same row), while others may require scrolling down. In light of this, we say that a target item and its substitute are "neighbors" if they appear on the same line on the website. Figure 3 displays an illustrative screenshot from the website. The target item that is shown, organic bananas, was on sale for $0.24 per unit (regular price $0.49), while the two corresponding - and adjacent - substitutes are "banana ripe" and "banana mild green" whose prices remained constant at $0.39 per unit. Six out of the twenty-eight product categories were neighbors (avocados, bananas, kiwis, lemons, raspberries, and water).[15] These neighboring categories made up roughly a quarter of purchases of target items and almost a third of substitute item purchases (as evident from Tables 2 and 3 there were no significant differences between the prices of neighboring and non-neighboring items). If comparing prices among neighboring items is simpler, we would expect shoppers to be more likely to purchase a discounted target item in these categories.

5 Findings

We begin this section by examining how all shoppers respond to exogenous price changes, and then measure the impact of information on this response by differentiating between shoppers in the treatment and control groups. Surprisingly, our results suggest that the treatment group responds by purchasing more of the higher-priced (weakly lower-quality) substitute items.

One explanation for the differential response of the treatment group is that the emails they received increased the salience of specific categories. In Section 5.2, we

[15] The twenty-two non-neighboring product categories are: apples, bulk apples, blueberries, pineapples, broccoli, cucumbers, kale, onions, green onions, peppers, lettuces, limes, tomatoes, bread, organic bread, eggs, brown eggs, organic eggs, milk, bulk milk, organic milk, yogurt. See a detailed explanation in Tables 2 and 3.

examine the relevance of this explanation by focusing on two groups of product categories where the salience gap between the treatment and control group varied. First, we consider categories that appeared at the *top* of the email sent to the treatment group. We test whether there is a larger difference in shopping response between the treatment and control group in these more salient product categories.[16] Second, we focus on purchases in the rebate item category. While only treatment shoppers were notified of sales, both treatment and control shoppers were encouraged to buy in the rebate item category. This provides an opportunity to differentiate between a salience shock that shoppers in both the treatment and control group received and an information shock that was received only by treatment shoppers.

In Section 5.3, we consider how the precision of information conveyed in the treatment email impacted the purchasing decision of the treatment group. We focus on specific weeks of the experiment where treatment shoppers received more information on the types of items that were on sale, as well as "nudges" that there exist cheaper alternatives to products they purchased on previous trips.

5.1 How do Shoppers Respond to Sales?

We find that the average shopper increases her purchase rate of an item when it goes on sale. Figure 4 graphs the fraction of shoppers purchasing a target item within a category (which includes target and substitute items) over time relative to the two weeks right before an item went on sale. Each item category is mapped to time 1 during the first two weeks it is on sale, and to time 2 for the last two weeks of it remaining on sale. The purchase rate in time 3 refers to the purchase rate two weeks after the sale relative to the two weeks prior to the sale. Prior to the sale, shoppers chose the target item in roughly 23 percent of purchases. During the first two weeks of the sale shoppers were 6.5 percentage points (s.e. 3.1) more likely to choose the on-sale item versus its alternative than they had been prior to the sale. This number increases to roughly 15.5 percentage points (s.e. 4.9) in the last two weeks of the sale.[17] Thus, at its peak, the sale resulted in shoppers choosing the on-sale item in roughly 38 percent of purchases.

[16] In the first three weeks of the experiment, this line focused on the vegetables category; weeks four and five focused on eggs; weeks six through nine focused on yogurt; and weeks ten through thirteen focused on milk.

[17] This specification controls for category and shopper fixed effects, although results are very similar without these controls.

Does the sale response illustrated in Figure 4 imply that shoppers that had previously purchased the substitute item switched to purchasing the target item during the sale period? Could some of this effect be driven by an increase in category purchases versus movements within the category? To differentiate between these effects, we focus on how the intervention impacted three different decisions of shoppers: buy_{icw}- the choice to purchase within a category where a discount occurred (e.g., tomatoes), $target_{icw}$- the choice to purchase the discounted item (e.g., organic tomatoes), and $substitute_{icw}$−the choice to purchase an alternative item within the category (e.g., conventional tomatoes). Thus, we model decision Y_{icw} of shopper i regarding items in category c during week w ($Y_{icw} = buy_{icw}, target_{icw}, substitute_{icw}$) as a linear function of whether or not the target item was on sale ($TSale_{cw}$),

$$Y_{icw} = \beta_0 + \beta_1 TSale_{cw} + \beta_2 TSale_{cw} \times hist_{ic} + \beta_3 hist_{ic} + \beta_4 rebate_{iw} + \gamma_i + \eta_c + \pi_w + \varepsilon_{icw} \quad (1)$$

Our analysis is conducted on the full sample of 355 shoppers (i) over the thirteen weeks of the experiment (w) in each of the 28 product categories (c). We allow the effect of the sale to be a function of whether the shopper has a history of purchasing within the category in the pre-experiment period. This provides an opportunity to examine whether the sales on this site serve to attract shoppers to new categories. All specifications include week, category, and shopper fixed effects, as well as a control for the size of the rebate offered to shopper if purchasing the rebate item.

The first column of Table 6, examines whether any item within category c was purchased by shopper i during week w ($Y_{icw} = buy_{icw}$). If the only effect of sales was to cause shoppers to replace a substitute item with a discounted target item, then we would expect the estimates in this column to be zero. The second column under the title "Target" examines the effect of a target item sale on the purchase rate of the on-sale target item ($Y_{icw} = target_{icw}$) The third column of the table under the title "Substitute" examines the effect of the target item sale on the purchase rate of the substitute item ($Y_{icw} = substitute_{icw}$). This analysis includes individuals in the sample who did not make a shopping trip during that week. For these shoppers, buy_{icw}, $target_{icw}$, and $substitute_{icw}$ are equal to zero for all product categories in that week.[18]

[18] Our results remain very similar when excluding these shoppers (see Appendix A).

The first three columns of Table 6 illustrate that the effect of the sale is concentrated among shoppers purchasing in a category in which they have a history of shopping previously. The average purchase rate within product categories was 0.8 percent (s.d. 9) with a rate of 0.2 percent (s.d. 5) buying target and 0.5 percent (s.d. 7.4) buying the substitute. We observe a general increase in purchasing rates within product categories during a target-item sale. For those shoppers with no history of buying within the category where the sale took place, there is a 0.1 percentage point (s.e. 0.04) increase in their purchase rate of the target item during the sale period (see column (2)). Shoppers who had already made a purchase in this category in the pre-experiment period increased their purchase rate of the target item by an additional 0.5 percentage points (s.e. 0.2), thereby tripling their purchase rate of the target item during the sale period (see column (2) coefficient on interaction term).

Despite these significant responses to the sale, Figure 4 still illustrates that while some shoppers move from purchasing the substitute to the target item when it goes on sale, many (60 percent) pay the same price or more to remain with the substitute item. Why did a significant proportion of shoppers choose apparently dominated alternatives on their shopping trips (more expensive and of lower quality)? One plausible explanation may be that shoppers were not fully attentive to all available discounts.

The last three columns of Table 6 differentiate between the response of shoppers who were randomly allocated to treatment (receiving a weekly promotional email with sale information and a rebate item category) and control (receiving a weekly promotional email with a rebate item category). We focus on intention-to-treat outcomes as opposed to limiting the sample to shoppers who made purchases or read the promotional email which could introduce selection concerns. Thus, columns (4), (5), and (6) examine shoppers' decisions from equation (1) when including an interaction term between whether or not the target item was on sale ($TSale_{cw}$) and assignment to the treatment group ($treat_i$),

$$\begin{aligned} Y_{icw} &= \alpha_0 + \alpha_1 TSale_{cw} \times treat_i + \alpha_2 TSale_{cw} \times treat_i \times hist_{ic} + \alpha_3 TSale_{cw} \\ &\quad + \alpha_4 TSale_{cw} \times hist_{ic} + \alpha_5 hist_{icic} + \alpha_6 hist_{ic} \times treat_i + \alpha_7 rebate_{iw} + \lambda_i + \delta_c + \rho_w + v_{icw} \end{aligned}$$

The estimated coefficients of this equation allow us to distinguish between the

effect of a sale on treatment shoppers *without* a history in the category ($\alpha_1 + \alpha_3$), treatment shoppers *with* a history ($\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4$), and the effects for shoppers in the control group with both no-history (α_3) and a history ($\alpha_3 + \alpha_4$) of purchases within the category. The last two rows of estimates in Table 6 labeled A and B, provide estimates of these aggregate sale effects for shoppers in both the treatment and control groups.

Shoppers in the treatment group were much more affected by sales than shoppers in the control (see column (4) of Table 6). Shoppers in the treatment group increased their purchase rate within the category of the sale by 1.6 percentage points (s.e. 0.6) more than control shoppers. Specifically, in product categories where they had made purchases in the past, they increased their purchase rate by 1.2 percentage points (s.e. 0.4) at an average purchase rate of 0.8 percent in the sample (see column (4), row (A)). If anything, shoppers with a history of purchases in the control group (see column (4), row (B)) decrease their purchase rate during this period by -0.4 percentage points (s.e. 0.4). Column (5) of row (A) suggests that some of this effect on purchasing rates is a result of increased purchases of the target item (an increase of 0.8 percentage points (s.e. 0.3)). The effect was smaller and more noisily measured for the control group (column (5) of row (B)). Those shoppers with a history of purchase in that category only increased their purchase rate of the target item by 0.3 percentage points (s.e. (0.3)).

The largest difference between the sale response of shoppers in the treatment and control groups relates to the purchase of *substitute* and *not* target items (the coefficient on $TSale_{cw} \times treat_i \times hist_{ic}$ as reported in column (6) of Table 6. Shoppers in the treatment group who have a history of purchasing in a category are 1.2 percentage points (s.e. 0.4) more likely than shoppers in the control group to purchase a substitute item during the period when the alternative target item was on sale (this estimate is the sum of the estimated coefficients on $TSale_{cw} \times treat_i \times hist_{ic}$ and $TSale_{cw} \times treat_i$).[19]

Why would receiving information on category sales *increase* the probability of purchasing a substitute item when the target item was of equal or higher quality at a lower price? Without a control group, one could be concerned that shoppers sus-

[19]This specification includes all shoppers in the analysis (even if they did not make a purchase in that week). If different sales draw different types of consumers to shop on the site then excluding non-shoppers could introduce selection bias into our results. Table 11 illustrates that our results are robust to excluding shoppers who did not make a purchase on the site during that week.

pected that an item on sale was of lower quality (e.g., close to expiration date).[20] But this cannot explain differential behavior between the randomly allocated treatment and control groups, as they both should have the same priors regarding the quality of on-sale items. One possible explanation is that the email to the treatment group impacted two separate shopping decisions. The first is what product categories to purchase, and the second, is whether to purchase the substitute or target item. In other words, receiving an email that notifies you that vegetables are on-sale may increase the probability of purchasing vegetables on the site. This increase could be driven by your interest in the sale and/or a salience reminder that you would like to buy vegetables (see Section 6). This salience reminder is unique to the treatment group and could lead to an increase in purchases of the substitute item. Purchasing the substitute may be especially likely in categories where this item is visually separated from the on-sale target item. Shoppers who have a history of buying in a given category are more likely to be familiar with the substitute items, which were purchased three to four times more frequently than the target items in the pre experiment period.

An alternative explanation to the differential information effect we just described is one of differential incentives. Recall that the size of the rebate ranged between \$2.99 and \$10 throughout the different weeks of the experiment. We control for rebate size in all specifications, as there were weeks where the treatment group received a \$10 offer, while control shoppers received a \$2.99 offer. In order to make sure that our results are not driven by a selection issue where certain types respond to a \$2.99 versus \$10 rebate offer, we re-run our analysis from Table 6 including only weeks when the treatment and control group received the same rebate offer. Table 7 illustrates that the observed differences in behavior between the treatment and control groups cannot be explained by differential incentives.

5.2 Heterogeneous Effects by Salience of Discount Category

Were some shoppers not aware of discounts, especially those where comparing prices comes at a greater cost? When we differentiate between categories where items appear in the same line of the website and categories where items are farther away,

[20] We look into this explanation in our post-study questionnaire and find that only three out of twenty-seven respondents said they did not buy an item on sale because they thought it was of lower quality or close to its expiration date.

the response to the sale (while noisy) appears higher for neighboring categories (see Figure 5). The peak response within neighboring categories is 26.2 percentage points (s.e. 8.3) versus 14.4 percentage points (s.e. 4.9) in non-neighboring categories.

In each of the following tables, we first measure the impact of the sale in all categories that include an on-sale item (column "All"), we then differentiate between categories with lower search costs where the target and substitute item appear on the same line of the website (column "Same Line") and categories with higher search costs where the items appear on different lines (column "Diff Line"). We only include the purchasing decisions of shoppers in product categories where they have made a purchase in the pre-experiment period and control for individuals' pre-experiment history of purchases ($past\_purchases_{ic}$). Table 6 illustrates that these are the decisions most impacted by the target item sales.

If the salience of product categories is driving the purchasing patterns observed in Table 6, we might expect this phenomenon to be strongest in product categories that appeared *first* in the treatment email. It is specifically in these product categories where the treatment group received the largest salience shock (assuming they are impacted more by information they see first) and the control group did not receive any information. We examine shoppers' decisions from equation (1) when including an interaction term between whether or not the target item was on sale ($TSale_{cw}$), assignment to the treatment group ($treat_i$), and whether or not this item appeared *first* in the treatment email ($first_{cw}$) :

$$\begin{aligned} Y_{icw} &= \gamma_0 + \gamma_1 treat_i \times TSale_{cw} + \gamma_2 treat_i \times TSale_{cw} \times first_{cw} + \gamma_3 TSale_{cw} + \\ &\quad \gamma_4 TSale_{cw} \times first_{cw} + \gamma_5 first_{cw} + \gamma_6 first_{cw} \times treat_i + \gamma_7 rebate_{iw} + \\ &\quad \gamma_8 past\_purchases_{ic} + \lambda_i + \delta_c + \rho_w + v_{icw} \end{aligned}$$

While we include results for all categories, it is not surprising that our results are more precisely measured for non-neighboring product categories, as only one of the neighboring product categories (avocados) ever appeared first in the treatment email.

Table 8 compares the purchasing decisions of the treatment and control groups for general product categories versus first-appearing product categories. Purchases of the target item increased on average by 0.6 percentage points (s.e. 0.4) during the sale

period for shoppers in the control group in categories outside of the first-appearing product categories (see column (4) coefficient on *Target Sale*). Column (7) of Table 8 illustrates that this increase was driven primarily by "switchers" as control shoppers decreased their purchase rate of the substitute item by 0.7 percentage points (s.e. 0.4) during the sale period. As reported previously, the statistically significant difference between the response of the treatment and control is driven by the fact that treatment shoppers do not decrease their purchase rate of the substitute item. Specifically, treatment shoppers are one percentage point (s.e. 0.5) more likely than those in the control group to purchase a substitute of the on-sale item during the sale period in non-first-product categories (see column (7) coefficient on $Treat \times$ *Target Sale)*.

The effect of the sale on target item purchases made by the control group (see column (4) of row C) was smaller for the first-appearing product categories (and was even below regular purchase rates). For non-neighboring categories, first-appearing product categories were always those with the smallest discounts which may explain the lower interest in these items. However, the coefficient on $Treat \times$ *Target Sale* $\times First\_item$ suggests that the treatment group behaved differently in regard to these first-appearing product categories. The difference appears specifically in these non-neighboring categories where shoppers in the treatment group increase their purchase rate of the on-sale target items (column (2)) by an additional 1.8 percentage points (s.e. 0.8) relative to the control group at an average purchase rate of 0.8 percent (s.d. 9.1).[21] Thus, the differences between the treatment and control group are largest for these more salient first-appearing product categories.

In order to further examine the source of the increased purchasing rate of substitute items during a sale period, we differentiate between the general effect of a sale and the effect of a sale in the rebate item category in Table 9. This comparison is important because shoppers in both the treatment and control group received a salience reminder to purchase in the rebate item category (or restock this category), whereas only the treatment group received a summary of the other product categories where sales were taking place. If we find that treatment shoppers respond more strongly than control to a sale in the rebate item category, then this impact is likely driven specifically by the sale information they received. Observed differences in responses

[21] The differential effect of the sale on first-appearing products between the treatment and control groups is calculated as the sum of the coefficients on $Treat \times$ *Target Sale* and $Treat \times$ *Target Sale*$\times$*first.*

between the treatment and control groups in other categories, is a combined result of the restock reminder and sale information.

We examine shoppers decisions from equation (1) when including an interaction term between whether or not the target item was on sale ($TSale_{cw}$), assignment to the treatment group ($treat_i$), and whether or not this item was included in the rebate item category ($rebate\_cat_{cw}$) :

$$\begin{aligned} Y_{icw} &= \mu_0 + \mu_1 treat_i \times TSale_{cw} + \mu_2 treat_i \times TSale_{cw} \times rebate\_cat_{cw} + \mu_3 TSale_{cw} \\ &\quad + \mu_4 rebate\_cat_{cw} + \mu_5 rebate_{iw} + \mu_6 past\_purchases + \lambda_i + \delta_c + \rho_w + v_{icw} \end{aligned}$$

Column (5) of Table 9 illustrates that shoppers in the treatment group are much more likely to purchase a target item in the rebate category than the control group when the target and substitute items are "neighbors" (an increase of 2.8 percentage points (s.e. 1.4) relative to an average purchase rate of 1.6 percent (s.d. 12.7)).[22] This effect does not appear for other items.

The coefficient on $Treat \times$ *Target Sale* in specification (7) of Table 9 suggests that the treatment group increased their purchase rate of substitute items relative to the control group during the target item sale for categories outside of the rebate item (an increase of 1 percentage point (s.e. 0.4)). Note, that while the increase in treatment purchases of the target item was driven by neighboring categories (column (5)), the increase of substitute purchases is driven by non-neighboring categories (column (9)).

5.3 Heterogeneous Effects by Coarseness of Information on Discounts

In Table 10 we consider the impact of more detailed emails on the treatment group. During the detailed weeks, the email included a line alerting shoppers to the fact that many organic items are on sale, and in some cases, even cheaper than the non-organic alternative. Additionally, if the shopper in the treatment group had purchased a substitute item in her previous trip, these personalized emails included the line "you may want to consider some alternatives to your last purchase in category — that are now on sale." We focus our analysis on the twenty categories where the target

[22] The differential effect of the sale on rebate items between the treatment and control groups is calculated as the sum of the coefficients on $Treat \times$ *Target Sale* and $Treat \times$ *Target Sale* $\times$ *Rebate_item*.

item is organic and examine shoppers decisions from equation (1) when including an interaction term between whether or not the target item was on sale ($TSale_{cw}$), assignment to the treatment group ($treat_i$), and whether or not this was a week where treatment shopper received a more detailed email ($detailed_w$) :

$$\begin{aligned} Y_{icw} &= \pi_0 + \pi_1 treat_i \times TSale_{cw} + \pi_2 treat_i \times TSale_{cw} \times detailed_w + \pi_3 TSale_{cw} \\ &\quad + \pi_4 TSale_{cw} \times detailed_w + \pi_5 detailed_w + \pi_6 detailed_w \times treat_i + \pi_7 rebate_{iw} \\ &\quad + \pi_8 past\_purchases_{ic} + \lambda_i + \delta_c + \rho_w + v_{icw} \end{aligned}$$

During the non-detail weeks (row A of Table 10), the significant observed change in shopping behavior is that shoppers in the treatment group increase their purchase rate of non-organic items (substitutes) by 1.5 percentage points (s.e. 0.6) in categories that include an on-sale organic item (column (7)). This effect is unique to non-neighboring categories, as treatment shoppers, if anything, decrease their purchase rate of substitutes by 0.9 percentage points (s.e. 1.7) in neighboring categories (column (8)). During this same period, the control group does not exhibit any significant change in shopping behavior (see coefficient on *Target Sale* across all specifications).

During the detailed email weeks (row B of Table 10), shoppers in the treatment group increase their purchase rate of on-sale organic target items by 0.9 percentage points (s.e. 0.5) and are much less likely to purchase the substitute items in these categories than they were during the non-detail weeks (a measured increase of 0.2 percentage points (s.e. 0.5)). But since we observe a similar increase of 0.7 percentage points (s.e. 0.4) in purchase of the target items among control shoppers during these detail weeks (column (4) of row C), we cannot attribute this to an information effect.[23] Thus, the effect of more detailed information was primarily a reduction in purchasing "mistakes" of the substitute item for treatment shoppers.

Our results suggest that the way information was presented in the treatment email impacted shopper choices. The difference in purchase rates of the on-sale target items between treatment shoppers and control shoppers was largest in categories that appeared first in the email and in situations where both groups received a

[23] This difference between detail and non-detail weeks could be driven by differences in the target items that were on sale, or in the size of the offered discount.

saliency shock to the category (rebate product categories). But the observed increase in substitute item purchases for the treatment group is fairly similar across these different salience categories. While we do observe a decrease in this "mistake" during detailed email weeks, the additional detail did not significantly increase the likelihood of treatment shoppers purchasing the on-sale target item. In other words, it seems information helped shoppers to avoid these "mistakes" by simply not purchasing in the category, as opposed to purchasing the on-sale item.

6 A simple model

In this section we propose a simple stylized model that illustrates a possible mechanism that can generate our main finding: In an environment with *vertically* differentiated goods, information on discounts in some product category can raise the demand of the *non*-discounted items in that category. While several ingredients in our model can be generalized, our purpose here is to provide the *simplest* and most transparent model that has the following features:

- When a shopper initiates a shopping trip, she may not remember or notice that she needs to restock some product.
- Advertisements provide only coarse information about sales, for example, by listing only the broad category of products that are on sale (e.g., "dairy products are on sale").
- An advertisement can remind a shopper that she needs to buy some item.
- A product category consists of a "premium" brand (in the sense that it is of higher quality than the other brands in the category and typically more expensive) that is bought only when it goes on sale.
- A shopper, who knows that some broad product category has items on sales, is uncertain about whether the premium brand is on sale *even* after she observes that another non-premium brand in that category is *not* on sale.

Consider a shopper who initiates a shopping trip whenever she realizes that a certain number of products, which she regularly consumes, need to be restocked. For simplicity, assume that the shopper consumes two product types, X_1 and X_2. Let

$x_i \in \{0,1\}$ denote whether product type i needs to be restocked ($x_i = 1$) or not ($x_i = 0$). The random variables x_1 and x_2 are uniform and independent. When (x_1, x_2) is realized, the shopper learns either X_1 or X_2 with equal probability. Conditional on learning x_i, $i = 1, 2$, there is probability r that the shopper also learns the value of x_j. To express this formally, let $R(x_1, x_2)$ denote the random variable that assigns to each realization (x_1, x_2) the set of items that the shopper knows that need to be restocked. The following table depicts the distribution of $R(x_1, x_2)$ for each possible realization (the columns displays the realization (x_1, x_2) and each row displays the possible values that R can take):

	$(1,1)$	$(1,0)$	$(0,1)$	$(0,0)$
$\emptyset$	0	$\frac{1-r}{2}$	$\frac{1-r}{2}$	1
$\{1,2\}$	$\frac{r}{2}$	0	0	0
$\{1\}$	$\frac{1-r}{2}$	$\frac{1+r}{2}$	0	0
$\{2\}$	$\frac{1-r}{2}$	0	$\frac{1+r}{2}$	0

We depart from the standard Bayesian paradigm by assuming that when $j \notin R(x_1, x_2)$, the shopper is *unaware* of the need to check whether X_j needs to be restocked. This means that when $R(x_1, x_2) = \{i\}$, the shopper does not engage in Bayesian updating to make inferences of whether x_j needs to be restocked. We interpret this assumption as capturing a situation where the shopper notices that one of the product types needs to be restocked, but she may not notice, or may not remember, whether another product type also needs to be restocked. We assume that there is a small cost for initiating a shopping trip such that a shopper starts shopping if and only if she learns that $x_i = 1$ for some $i \in \{1, 2\}$.

Each product type i is supplied by N perfectly substitutable "standard" brands $A_i^1, ..., A_i^N$ and one "premium" brand B_i. The shopper has a unit demand for each product type (hence, she buys at most two items) and quasi-linear preferences, where her willingness to pay for a brand A_i^n, $n = 1, ..., N$ is a_i, while her willingness to pay for brand B_i is $b_i > a_i$.[24] The prices of each brand are stochastic and set exogenously

[24] As the proof of Proposition 1 shows, the role of the n identical "standard" brands is to ensure that a shopper is uncertain whether the premium brand is on sale when he observes a promotional message that products in a category are on sale, and he finds out that one standard brand is not on sale.

by the shop.[25] Specifically, the price of each A_i^n, denoted $p(A_i^n)$, is equal to ℓ_i with probability $\pi_A < \frac{1}{2}$ and equal to $h_i > \ell_i$ with probability $1 - \pi_A$, while the price of B_i, denoted $p(B_i)$, is equal to ℓ_i with probability $\pi_B < \pi_A$, but equal to $h_i + \Delta_i$ with probability $1 - \pi_B$, where $\Delta_i > 0$. We assume that $b_i - \Delta_i < h_i < a_i$, so that the shopper is willing to buy brand A_i^n even at the high price, but is unwilling to buy the premium brand at its high price.

To capture the idea that the shop advertises sales, we assume that whenever the price of a brand is at its low value, the shop sends an announcement to the shopper. The announcement is coarse in the sense that only the product type i that includes a low-priced brand is announced. Formally, given a realization of prices $(p(A_i^n), p(B_i))_{i=1,2}^{n=1,..,N}$, the shop sends a message

$$m = \{i \in \{1,2\} : p(A_i^n) = \ell_i \text{ for some } n \in \{1,...,N\} \text{ or } p(B_i) = \ell_i\}$$

The motivation for the coarse messages is that the shop offers many product categories and many brands in each category, and hence, it cannot include in an email to the shopper all the brands that are on sale.[26] We assume that when $i \in m$ the shopper is reminded of the X_i product category, and of the need to check whether that product type needs to be restocked. If $i \in R(x_1, x_2)$, then this does not change the behavior of the shopper as she already learned the value of x_i. But if $i \notin R(x_1, x_2)$, then a message that includes i leads the shopper to learn the value of x_i.

After observing m the shopper engages in a directed sequential search. He decides which item (a brand of some product type) to search for first. Searching for an item entails a cost of c. In order to buy an item the shopper must search for it and place it in her basket. Once an item is searched, the shopper learns its price. Given the observed price and m, the shopper decides whether to buy the item, continue searching (which entails an additional cost of c) or end the shopping trip. After a sequence of searches, the shopper can buy any of the searched item with *no* additional cost. This assumption captures the idea that the searched items are in the shopper's basket and it is immediate to remove any item before checkout.

[25] A richer model would endogenize these prices by having the shop best respond to the behavior of the shopper. This is an interesting extension, but one that is beyond the scope of the present paper. We interpret our assumption of exogenous sales as reflecting the fact that the sales are decided on by the manufacturer and not the retailer.

[26] Indeed, typical promotional emails by retailers often announce only broad categories that are on sale (e.g., "jeans are half off")

In sum, the timeline of the shopper's decision problem is as follows. First, the shopper gets a signal about the realization of (x_1, x_2) (she either learns (x_1, x_2) or just the realization of one of the components). Next, she receives the shop's message m and makes her search and purchasing decisions.

Our aim is to show that this model is able to generate a behavior similar to our finding whereby a message announcing a sale in category i can induce the shopper to buy a non-discounted brand.

Proposition 1 *Suppose* $x_i = 1$, $R(x_1, x_2) = \{j\}$ *and* $p(B_i) = \ell_i$. *If*

$$(b_i - a_i) + (h_i - l_i) < c < a_i - \pi_A \ell - (1 - \pi_A) h_i \tag{2}$$

then with probability $(1 - \pi)$ *the shopper will buy some standard brand* A_i^n *for a price of* h_i.

The proposition provides sufficient conditions for a promotional announcement of a sale to increase the demand of a non-discounted item. When $R(x_1, x_2) = \{j\}$ the shopper initiates a search not knowing whether X_i needs to be restocked. However, when category i is discounted, the ad will remind that shopper that she also needs to shop in that category. Since it is more likely that the standard brand is cheaper, if the search cost is at an intermediate level, the shopper will find it optimal to search only for a standard brand, and will end up buying it, even when the premium brand is discounted.

It is straightforward to verify that if the shop's message was precise, so that it specified the brand that is on sale, then the shopper will never buy a standard brand whenever the premium brand is on sale.

Proof of Proposition 1. Since $p(B_i) = \ell_i$ the shop will send a message that includes the product category i. Since $R(x_1, x_2) = \{j\}$, this message will lead the shopper to learn that $x_i = 1$. The shopper then needs to decide whether to search in product category i and which brand to search for first.

Case 1. Suppose the shopper searches first for some standard brand A_i.

Since all the standard brands are i.i.d., it does not matter with which standard brand the shopper starts. Suppose she starts with some A_i^n. Consider first the subcase $p(A_i^n) = h_i$ that occurs with probability $(1 - \pi)$. Note that since there are several standard brands, the fact that $i \in m$ but $p(A_i^n) = h_i$ does not imply that the premium

brand is necessarily discounted: There are $N-1$ other standard brands that could be discounted. Indeed, the probability that one of them is discounted, conditional on $i \in m$ and $p(A_i^n) = h_i$ is equal to

$$\frac{1-(1-\pi_A)^{N-1}}{1-(1-\pi_A)^{N-1}+\pi_B}$$

If the shopper stops her search, her payoff will be $a_i - h_i$. If she continues searching for another standard brand, the highest payoff she can obtain is $a_i - l_i$. If $c > h_i - l_i$, the shopper prefers not to search for another standard brand. If she continues searching for a premium brand, the highest payoff she can obtain is $b_i - l_i$. If $c > (b_i - a_i) + (h_i - l_i)$, the shopper would prefer to stop the search and purchase A_i^n for the high price h_i. This implies that also in the the subcase $p(A_i^n) = l_i$ the shopper will prefer to stop the search and purchase the standard brand.

Case 2. Suppose the shopper searches first for the premium brand.

If $p(B_i) = l_i$ the shopper will stop the search and purchase the premium brand. But if $p(B_i) = h_i$, the shopper will decide whether to stop and not purchase the product X_i, or to search for some standard brand. The worst payoff she can obtain from searching is $a_i - h_i$. If $c < a_i - h_i$, the shopper will continue searching for a standard brand.

It remains to verify whether the shopper prefers to search first for a standard or premium brand. If she searches first for a standard brand, then her expected payoff would be equal to

$$a_i - \pi_A \ell - (1-\pi_A)h_i - c$$

which is non-negative by (2). If the shopper decides to search first for a premium brand, her expected payoff would be equal to at least

$$\pi_B(b_i - \ell_i - c) + (1-\pi_B)(a_i - h_i - 2c)$$

Therefore, if

$$c \geq \frac{\pi_B}{1-\pi_B}(b_i - a_i) - \frac{\pi_A - \pi_B}{1-\pi_B}(h_i - \ell_i)$$

the shopper will prefer to start searching for a standard brand. By (2) this inequality necessarily holds. From the analysis above, it follows that the shopper will end up purchasing the standard brand, and with probability $1-\pi_A$ she would pay h_i for it.

■

7 Discussion

Our main finding is that providing shoppers with information on categories with on-sale items increases the purchase rate within the category for the *regularly* priced substitutes. This behavior may be viewed as anomalous if the following is true:

1. Shoppers prefer organic items if they are not more expensive than their non-organic counterparts.

2. Shoppers would switch brands if a competing brand is reduced to, or below, the price of the regular brand they usually purchase.

To verify these assertions, we conducted two follow- up surveys. The first was sent only to the participants of our study and had a response rate of only 24 percent (55 shoppers). 91 percent of the responders answered that they would choose an organic item if it was weakly cheaper than its non-organic alternative. 80 percent of the responders reported that they would switch brands for a discount of 20 percent.

Because of the low response rate of our first follow-up survey, we conducted an additional survey using the Qualtrics platform on 378 American participants ranging from 18 to 30 years old, with at least some college education. Over 70 percent of respondents reported that they would choose organic if it was the same price as the non-organic alternative for prices ranging between \$1.00-\$3.50. This climbs to close to 90 percent when organic is cheaper than the non-organic alternative. Lastly, 68 percent of respondents replied that they would switch brands if the alternative brand was discounted to the same price as the item they usually purchased. This climbs to 80 percent when the discounted alternative becomes cheaper than the item they usually purchase.

These survey results lend support to our interpretation of the data as reflecting shopping behavior under limited attention. The behavior of our participants stands in stark contrast to the vast majority of the survey responses. While our finding that promotional materials on sales increases consumption of regularly priced alternatives is not dependent on assumptions (1) and (2), these assumptions have important implications regarding consumer welfare.

8 Concluding remarks

Comparing prices across a large variety of products is a non-trivial task, especially when prices are constantly changing. Much of the economic analysis is based on the premise that individuals are attuned to all price fluctuations and perfectly process signals of these price changes. In contrast, the results of our field experiment show that individuals can miss opportunities to save and tend to focus on price comparisons that are more salient. Moreover, a significant proportion of individuals forego opportunities to save that are brought to their attention. Indeed, a surprising conclusion that arises from our findings is that it is not straightforward to draw individuals' attention to price changes that can help them save, even when they are provided with personalized messages. Our analysis suggests that the advertising of sales can end up increasing purchase rates of all items in the category in which a sale is taking place. Specifically, information on items within category sales can increase purchase rates of both the on-sale item and other alternatives in that category. If promotional materials increase "mistakes" among consumers, firms could profit by increasing prices of "substitutes" while advertising "target" discounts.

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Figure 1: Examples of Email Format During Basic Weeks

Control (email title: Free Shipping on ---- if you Buy a Banana!!!)

Greetings from ----, your local grocery delivery service!

Got a banana? Get a one-time refund on shipping for a purchase of over $20 if you buy one banana or more![1](Click here)

[1] Offer valid on all bananas. Use this email address when placing your purchase and a refund of $2.99 will be applied within 24 hours of purchase. Valid until ---

Treatment (email title: Free Shipping on ---- if you Buy a Banana!!!)

Greetings from ----, your local grocery delivery service!

Got a banana? Get a one-time refund on shipping for a purchase of over $20 if you buy one banana or more![1] (Click here)

… and if that's not enough, make sure you check our discounts for the month of February (discounted items are marked by **).

Our biggest discounts are in the following categories:

1. Vegetables – up to 45% off select items (Click here)

2. Milk – up to 40% off select items (Click here)

3. Fruits – up to 30% off select items (Click here)

4. Eggs – up to 20% off select items (Click here)

[1] Offer valid on all bananas. Use this email address when placing your purchase and a refund of $2.99 will be applied within 24 hours of purchase. Valid until ---

Figure 2: Examples of Email Format During Detailed Weeks

Control: (email title: Click for $10 off your ---- purchase!!)

Greetings from ----, your local grocery delivery service!

Got apples? Get a $10 refund by simply purchasing at least one apple and inserting the coupon code dcash at checkout! [1] (Click here)

[1] Offer valid on all apples. Use this email address and the dcash coupon code when placing your purchase and you will receive a $10.00 one-time refund on your purchase of $20 or more. The refund will be applied within 24 hours. Valid until ---.

Treatment: (email title: Click for $10 off your ---- purchase!!)

Greetings from ----, your local grocery delivery service!

We are devoted to helping our customers get the "best bang for the buck".

So don't miss out on our April discounts! Our April sale prices are so low that organic sale items are often even cheaper than the non-organic alternative! (discounted items are marked by **)

Don't forget to consider some alternatives to your last purchase of eggs that we have on sale this month.

To use your $10 refund - simply click on one of the links below to the site, purchase at least one apple and insert the coupon code found below.

Our biggest discounts are on the following products:

1. Milk – up to 33% off select items (Click here)

2. Eggs – up to 49% off select items (Click here)

3. Fruit – up to 51% off select items (Click here).

4. Vegetables – up to 75% off select items (Click here)

Make sure to purchase one or more apples and enter coupon-code dcash at checkout![1]

[1] Offer valid on all apples. Use this email address and the dcash coupon code when placing your purchase and you will receive a $10.00 one-time refund on your purchase of $20 or more. The refund will be applied within 24 hours. Valid until ---.

Figure 3: Example of Target versus Substitute Item During Sale Period

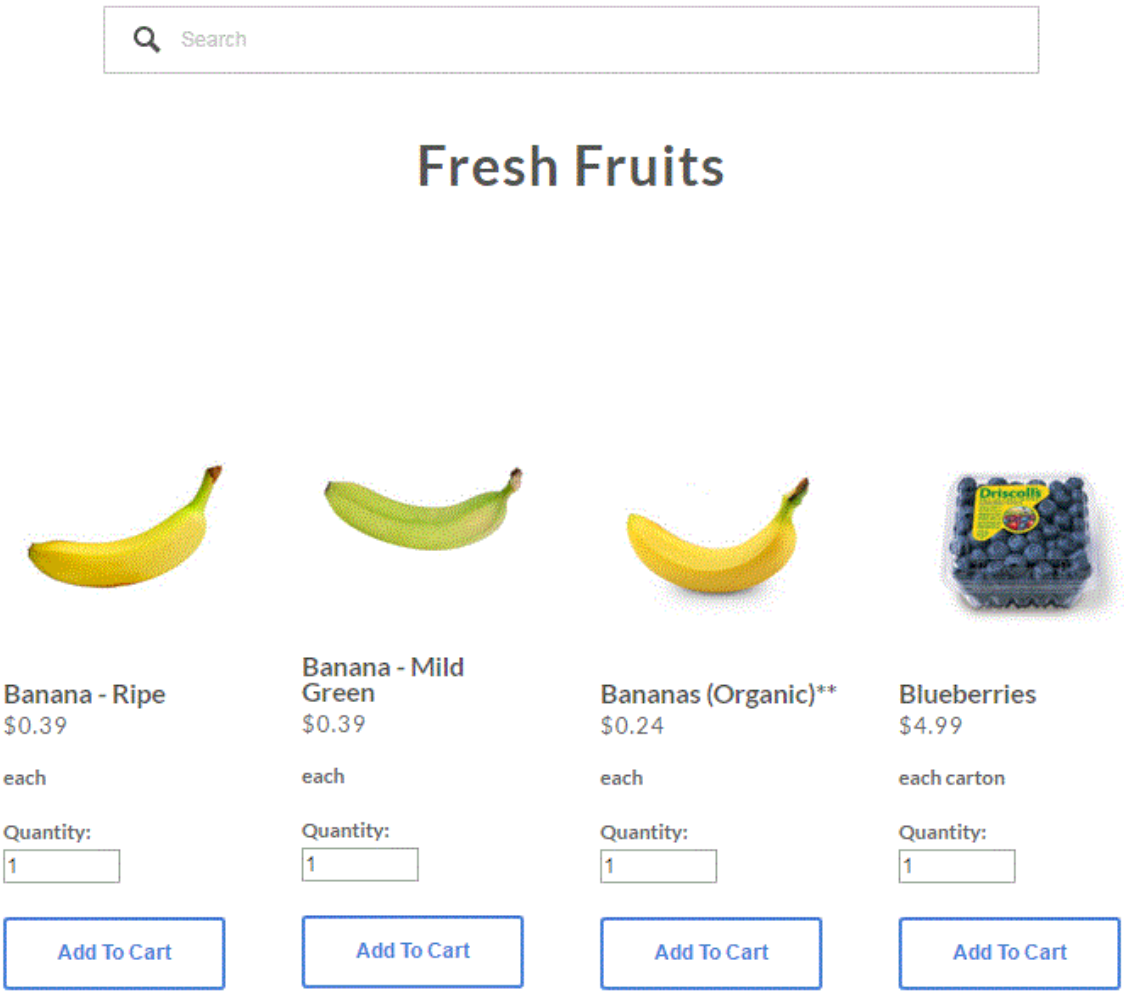

Figure 4: The Effect of a Sale on the Fraction of Shoppers Purchasing a Target vs. Substitute Item

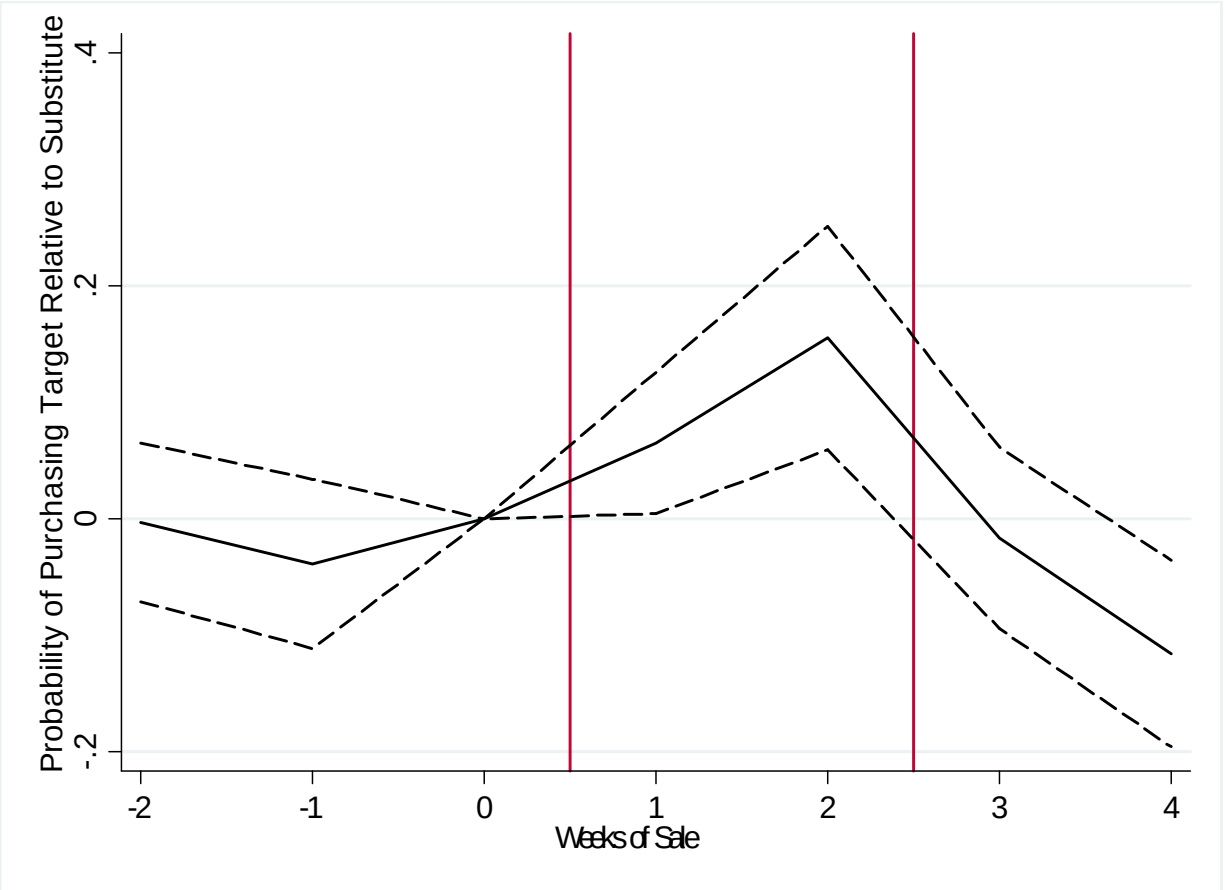

Figure 5: The Effect of a Sale on the Fraction of Shoppers Purchasing a Target vs. Substitute Item

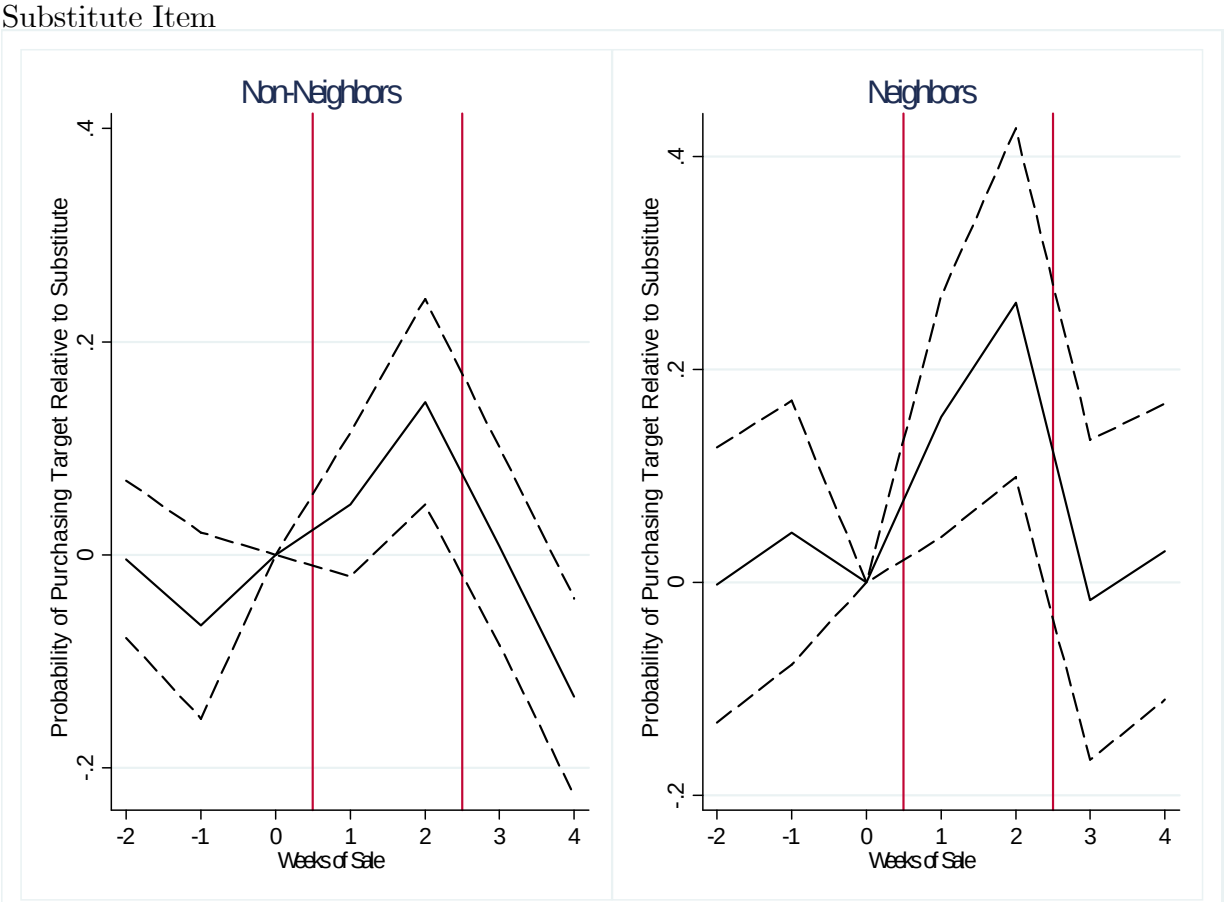

Table 1: Purchasing Frequency of Target and Substitute Items Prior to Experiment

Product Name	Quantity Purchased
Bananas	***357***
Bananas (Organic)	72
Onions	***191***
Onions (Organic)	42
Kroger: Bread	***139***
Aunt Millie's Bread	56
Kroger: Eggs - 12ct	***134***
Egg-Lands Best: Cage Free Large Brown Eggs - 12ct	14
Kroger: Grade A Large Brown Eggs - 12ct	19
Simple Truth: Natural Cage Free Large Brown Eggs - 12ct	78
Kroger: Milk (1gal)	***114***
Kroger: Milk (0.5gal)	96
Horizon: Organic Milk (0.5gal)	22
Simple Truth Organic: Milk (0.5gal)	43
Apple (Lg)	***103***
Apple (Organic)	69
Apple Bag - 3 lb bag	65
Bell Pepper	***99***
Bell Pepper (Organic)	15
Blueberries	***94***
Blueberry (Organic)	11
Avocado	***76***
Jumbo Avocado	28
Cucumber	***75***
Cucumber (Organic)	15
Ice Mountain: Water - 24pk	***74***
Kroger: Purified Drinking Water - 24pk	11
Dasani: Water - 24pk	20
Aquafina - 24pk	11
Chobani: Greek Yogurt	***71***
Fage: Greek Yogurt	55
Raspberries	***62***
Raspberries (Organic)	10
Roma Tomato	***41***
Roma Tomato (Organic)	4
Romaine Lettuce	***33***
Romaine Lettuce (Organic)	3

The most popular substitute item within each category appears first and in bold. Broccoli, Kiwi, Kale, Pineapples, Lemons, Limes, Green Onions, Organic Bread, and Organic Eggs were excluded from this table for lack of space.

Table 2: Target and Substitute Produce Items

Weeks	Target Item	Price	Sale Price	Substitute Item	Price
1-5	Organic Banana **(N)**	0.49	0.39	Regular Banana	0.39
1-5	Organic Blueberries	5.49	4.99	Regular Blueberries	4.99
1-5	Organic Kiwi **(N)**	0.99	0.79	Regular Kiwi	0.79
1-5	Organic Apple (Fuji)	1.49	1.25	Regular Apple (Fuji)	1.25
1-5	Organic Apple (Gala)	1.49	1.25	Regular Apple (Gala)	1.25
1-5	Organic Apple (Granny Smith)	1.49	1.25	Regular Apple (Granny Smith)	1.25
1-5	Organic Lime	1.29	0.89	Regular Lime	0.89
1-5	Organic Broccoli	3.49	3.25	Regular Broccoli	3.25
1-5	Organic Romaine Lettuce	3.29	2.59	Regular Romaine lettuce	2.59
1-5	Organic Cucumber	1.89	0.99	Regular Cucumber	0.99
1-5	Jumbo Ripe Avocado **(N)**	2.25	1.49	Jumbo Unripe Avocado	2.25
6-9	Organic Tomato	0.79	0.59	Regular Tomato	0.59
6-9	Organic Red Bell Pepper	2.79	2.59	Regular Red Bell Pepper	2.59
6-9	Organic Onion	2.59	1.99	Regular Sweet Onion	1.99
6-9	Organic Kale	2.19	1.99	Regular Kale	1.99
6-9	Organic Green Onion	0.99	0.95	Regular Green Onion	0.95
6-9	Apples 3 lb bag (~4 ct.)	5.39	4.49	Regular Apple	1.25
6-9	Organic Lemon **(N)**	1.49	1.29	Regular Lemon	1.29
6-9	Organic Pineapple	6.49	5.49	Regular Pineapple	5.49
10-13	Organic Banana **(N)**	0.49	0.24	Regular Banana	0.39
10-13	Organic Blueberries	5.49	4.00	Regular Blueberries	4.99
10-13	Organic Apple	1.49	1.00	Regular Apple	1.25
10-13	Organic Apple (Fuji)	1.49	1.00	Regular Apple	1.25
10-13	Organic Raspberries **(N)**	5.49	3.89	Regular Raspberries	3.99
10-13	Organic lemon **(N)**	1.49	0.99	Regular Lemon	1.29
10-13	Organic Broccoli	3.49	2.00	Regular Broccoli	3.25
10-13	Organic Cucumber	1.89	0.75	Regular Cucumber	0.99
10-13	Roma Tomato Organic	0.79	0.20	Regular Tomato	0.59
10-13	Red Bell Pepper Organic	2.79	1.99	Regular Red Bell Pepper	2.59
10-13	Sweet Onion Organic	2.59	1.00	Regular Sweet Onion	1.99
10-13	Organic Green Onion	0.99	0.50	Regular Green Onion	0.95

(N) – refers to neighboring categories where the target and substitute appear on the same line of the website.

Table 3: Target and Substitute Dairy, Egg, and Durable Items

Dairy

Weeks	Target Item	Price	Sale Price	Substitute Item	Price
1-5	Kroger: Milk (0.5gal)	2.99	1.75	Kroger: Milk (1gal)	3.99
1-5	Horizon Organic: 0% fat free Milk (0.5gal))	5.45	4.49	Simple Truth Organic: Fat Free Milk	4.49
1-5	Fage: 0% and 2% fat Yogurt (plain and cherry)	1.89	1.50	Chobani: Yogurt, Fage: Yogurt (Other)	1.89
6-9	Fage: 0% and 2% fat Yogurt (plain and cherry)	1.89	1.50	Chobani: Yogurt, Fage: Yogurt (Other)	1.89
10-13	Simple Truth Organic: Milk (0.5gal)	4.49	2.99	Horizon Organic: Milk	5.45

Eggs

Weeks	Target Item	Price	Sale Price	Substitute Item	Price
1-5	Kroger: Grade A large Brown Eggs-12ct	3.69	2.89	Kroger Grade A Large Eggs-12ct	2.99
1-5	Egg-Land's Best: Cage Free Large Brown Eggs-12ct	5.49	4.35	Simple Truth: Natural Cage Free Grain Fed Large Brown Eggs-12ct	4.45
10-13	Kroger: Grade A Large Brown Eggs-12ct	3.69	1.89	Kroger Grade A Large Eggs-12ct	2.99
10-13	Simple Truth: Natural Cage Free Grain Fed Large Brown Eggs-12ct	4.45	2.50	Kroger Grade A Large Eggs-12ct	2.99

Durables

Weeks	Target Item	Price	Sale Price	Substitute Item	Price
6-9	Kroger: Multigrain Bread	2.59	1.99	Kroger: 100% Whole Wheat Bread	2.59
6-9	Kroger: Wheat Bread	2.45	1.99	Kroger: Buttermilk Bread	2.19
6-9	Dasani: Water **(N)**	6.99	5.49	Ice mountain: Water	5.99
				Aquafina: Water	6.99
				Kroger: Water	5.49
				Niagara: Water	5.99
12-13	Aunt Millie's Bread: 100% Whole Wheat	3.65	2.19	Aunt Millies: 12 Whole Grain, Honey Oat, Honey Wheat, Multi Grain	3.65
				Kroger Whole Wheat	2.59
12-13	Aunt Millie's Bread: Butter Top White	3.65	2.19	Kroger: Buttermilk Bread, Wheat Bread	2.45
12-13	Aunt Millie's Bread: Whole Grain White	3.65	2.19	Aunt Millies: Italian	3.65
				Kroger: White, Italian	2.19

(N) – refers to neighboring categories where the target and substitute appear on the same line of the website.

Table 4: Offered Rebate Categories By Week

Week	Rebate Category	Rebate Item Price Target (in $'s)	Rebate Item Price Substitute (in $'s)	Rebate Item Refund Control Group	Rebate Item Refund Treat Group
1	Bananas	0.39	0.39	2.99	2.99
2	Blueberries	4.99	5.49	2.99	2.99
3	Apples	1.25	1.25	2.99	2.99
4	Broccoli	3.25	3.25	2.99	10
5	Bananas, Blueberries, Apples, or Broccoli	See Prices Above	See Prices Above	2.99	10
6	Tomatoes	0.59	0.59	2.99	10
7	Red bell pepers	2.59	2.59	2.99	10
8	Bread	1.99	2.59	2.99	10
9	Yogurt	1.5	1.89	2.99	10
10	Bananas	0.24	0.39	2.99	10
11	Apples	1	1.25	10	10
12	Bread	2.19	2.59	10	10
13	Eggs	2.5	2.99	10	10

Table 5: Sample Characteristics in Pre Experiment Period

	Full Sample			Target or Substitute History		
	Control[a]	Treat[a]	Diff[b]	Control[a]	Treat[a]	Diff[b]
Number of Shopping Trips	4.373	4.264	-0.097	4.829	4.732	-0.097
	(5.814)	(5.678)	(0.693)	(6.122)	(5.988)	(0.693)
Number of Items Purchased	12.544	13.039	0.856	13.529	14.385	0.856
	(7.157)	(8.553)	(0.883)	(7.017)	(8.337)	(0.883)
Number of Target Items Purchased:	2.198	2.758	0.65	2.559	3.209	0.65
(28 Categories)	(4.856)	(6.372)	(0.689)	(5.153)	(6.769)	(0.689)
Neighboring Categories:	0.599	0.702	0.103	0.697	0.817	0.120
(6 Categories)	(1.683)	(2.397)	(0.220)	(1.798)	(2.569)	(0.254)
Non-Neighboring Categories:	1.599	2.056	0.457	1.862	2.392	0.530
(22 Categories)	(3.900)	(4.989)	(0.475)	(4.151)	(5.308)	(0.546)
Number of Substitute Items Purchased:	8.565	8.360	-0.205	9.974	9.725	-0.248
(28 Categories)	(11.585)	(12.901)	(1.302)	(11.929)	(13.433)	(1.455)
Neighboring Categories:	2.904	2.427	-0.477	3.382	2.824	-0.558
(6 Categories)	(6.555)	(5.125)	(0.624)	(6.961)	(5.428)	(0.714)
Non-Neighboring Categories:	5.661	5.933	0.272	6.592	6.902	0.310
(22 Categories)	(7.341)	(8.624)	(0.850)	(7.525)	(8.937)	(0.946)
Number of Categories Purchased	4.260	4.500	0.240	4.961	5.235	0.275
	(3.587)	(3.690)	(0.386)	(3.390)	(3.462)	(0.392)
Total $ Amount Spent on Purchase	66.186	65.198	-0.988	70.957	70.166	-0.791
	(38.556)	(40.119)	(4.177)	(38.403)	(39.833)	(4.481)
Number of Shoppers	177	178		152	153	

[a]Standard deviations are presented in parenthesis

[b]Standard errors are presented in parenthesis

Our analysis focuses on 28 product categories. Six of these are classified as Neighbor Categories - categories where the substitute and target items appear on the same line of the webpage (avocados, bananas, kiwis, lemons, raspberries, and water). The remaining 22 non-neighboring categories are the following: apples, bulk apples, blueberries, pineapples, broccoli, cucumbers, kale, onions, green onions, peppers, lettuces, limes, tomatoes, bread, organic bread, eggs, brown eggs, organic eggs, milk, bulk milk, organic milk, yogurt. Target or Substitute History is a sample that includes only shoppers who made at least one purchase of a target or substitute good during the pre-experiment period.

*Significant at 10%; **significant at 5%; ***significant at 1%

Table 6: Average Effects of Sale and Treatment

	Baseline			Controlling for Information		
	Category	**Target**	**Substitute**	**Category**	**Target**	**Substitute**
	(1)	(2)	(3)	(4)	(5)	(6)
Target Sale (TS)	0.001**	0.001***	0.00003	0.001**	0.001**	0.0003
	(0.0004)	(0.0005)	(0.0003)	(0.001)	(0.0005)	(0.0004)
Target Sale X History	0.003	0.005**	-0.001	-0.006	0.002	-0.007**
	(0.003)	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)
History of Purchase	0.028***	0.006***	0.022***	0.029***	0.006***	0.022***
in Category (0/1)	(0.004)	(0.001)	(0.003)	(0.005)	(0.002)	(0.004)
High Rebate Week	0.005***	0.001	0.004***	0.005***	0.001	0.004***
(0/1)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Target Sale X Treat				-0.001	-0.0001	-0.001
				(0.001)	(0.001)	(0.001)
Target Sale X Treat X Hist				0.017***	0.005	0.012***
				(0.006)	(0.004)	(0.005)
Treat X Hist				-0.003	-0.001	-0.001
				(0.007)	(0.003)	(0.006)
Item Category FE's	X	X	X	X	X	X
Shopper & Week FE's	X	X	X	X	X	X
N ItemsxWeeks	129,220	129,220	129,220	129,220	129,220	129,220
Mean of Dependent	0.008	0.002	0.005	0.008	0.002	0.005
Variable:	[0.090]	[0.050]	[0.074]	[0.090]	[0.050]	[0.074]
<u>A. Change in Purchase Rate of Treatment Group with History During Sale Period:</u>						
TS + TSxHistory				0.012***	0.008***	0.005
+ TSxTreat + TSxTreatxHist				(0.004)	(0.003)	(0.003)
<u>B. Change in Purchase Rate of Control Group with History During Sale Period:</u>						
TS + TSxHistory				-0.004	0.003	-0.007**
				(0.004)	(0.003)	(0.003)

Standard errors are presented in parenthesis and clustered at the shopper level. Standard deviations appear in brackets. An observations is defined by a shopper, week, and item category. History of Purchase is equal to 1 if the shopper purchased either a substitute or target item in this category in the pre experiment period. A high rebate week refers to weeks when the rebate was $10 for purchasing the rebate item.
High rebate week=0 when the rebate was $2.99.
*Significant at 10%; **significant at 5%; ***significant at 1%

Table 7: Average Effects of Sale and Treatment (Identical Rebate Offers)

	Baseline			Controlling for Information		
	Category	**Target**	**Substitute**	**Category**	**Target**	**Substitute**
	(1)	(2)	(3)	(4)	(5)	(6)
Target Sale (TS)	0.001	0.0003	0.001	0.001	0.0004	0.001
	(0.001)	(0.0005)	(0.001)	(0.001)	(0.001)	(0.001)
Target Sale X History	0.001	0.006**	-0.003	-0.010	0.002	-0.010**
	(0.004)	(0.003)	(0.003)	(0.006)	(0.004)	(0.005)
History of Purchase	0.030***	0.005***	0.024***	0.037***	0.007***	0.029***
in Category (0/1)	(0.004)	(0.002)	(0.004)	(0.007)	(0.002)	(0.006)
High Rebate Week	-0.004*	-0.001	-0.004**	-0.004*	-0.001	-0.004**
(0/1)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)
Target Sale X Treat				-0.001	-0.0001	-0.001
				(0.001)	(0.001)	(0.001)
Target Sale X Treat X Hist				0.021**	0.007	0.014**
				(0.008)	(0.005)	(0.007)
Treat X Hist				-0.015	-0.004	-0.010
				(0.009)	(0.003)	(0.008)
Item Category FE's	X	X	X	X	X	X
Shopper & Week FE's	X	X	X	X	X	X
N ItemsxWeeks	59,640	59,640	59,640	59,640	59,640	59,640
Mean of Dependent	0.008	0.003	0.005	0.008	0.003	0.005
Variable:	[0.089]	[0.052]	[0.073]	[0.089]	[0.052]	[0.073]
A. Change in Purchase Rate of Treatment Group with History During Sale Period:						
TS + TSxHistory				0.012**	0.009***	0.004
+ TSxTreat + TSxTreatxHist				(0.005)	(0.003)	(0.004)
B. Change in Purchase Rate of Control Group with History During Sale Period:						
TS + TSxHistory				-0.008	0.003	-0.009*
				(0.006)	(0.004)	(0.005)

Standard errors are presented in parenthesis and clustered at the shopper level. Standard deviations appear in brackets. An observations is defined by a shopper, week, and item category. History of Purchase is equal to 1 if the shopper purchased either a substitute or target item in this category in the pre experiment period. A high rebate week refers to weeks when the rebate was $10 for purchasing the rebate item.
High rebate week=0 when the rebate was $2.99.
*Significant at 10%; **significant at 5%; ***significant at 1%

Table 8: Is the Sale Effect Different for First Line Categories?

	Purchase Item in Category			Buy Target			Buy Substitue		
	All	**Same Line**	**Diff Line**	**All**	**Same Line**	**Diff Line**	**All**	**Same Line**	**Diff Line**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treat X Target Sale (TS)	0.012*	0.014	0.010	0.003	0.007	0.001	0.010**	0.007	0.010*
	(0.006)	(0.016)	(0.006)	(0.005)	(0.013)	(0.004)	(0.005)	(0.013)	(0.006)
Treat X TS X First Item	0.015	-0.058	0.026*	0.012	-0.022	0.017**	-0.0001	-0.037	0.006
	(0.013)	(0.036)	(0.015)	(0.010)	(0.015)	(0.008)	(0.011)	(0.034)	(0.013)
Target Sale (TS)	-0.001	-0.001	-0.002	0.006	0.007	0.005*	-0.007*	-0.007	-0.007*
	(0.004)	(0.011)	(0.005)	(0.004)	(0.011)	(0.003)	(0.004)	(0.012)	(0.004)
First Item X Target Sale (TS)	-0.013	0.020	-0.018	-0.016*	-0.008	-0.015**	0.006	0.025	-0.0002
	(0.010)	(0.033)	(0.013)	(0.008)	(0.014)	(0.007)	(0.008)	(0.030)	(0.010)
N ItemsxWeeks	20,215	5,122	15,093	20,215	5,122	15,093	20,215	5,122	15,093
Mean of Dependent Variable:	0.037 [0.188]	0.055 [0.228]	0.030 [0.172]	0.010 [0.102]	0.016 [0.127]	0.008 [0.091]	0.026 [0.158]	0.037 [0.190]	0.021 [0.145]
Change in Purchase Rate of *Treatment* Group During *Sale Period*:									
A. Non First Item: TS+ Treat x TS	0.011**	0.013	0.008**	0.008**	0.014	0.006**	0.003	-0.0003	0.003
	(0.005)	(0.013)	(0.004)	(0.004)	(0.008)	(0.003)	(0.003)	(0.008)	(0.004)
B. First Item: TS+ Treat x TS + First x TS + Treat x TS x F	0.013	-0.025	0.016*	0.004	-0.016	0.008	0.009	-0.012	0.009
	(0.008)	(0.016)	(0.009)	(0.006)	(0.011)	(0.007)	(0.007)	(0.015)	(0.008)
Change in Purchase Rate of *Control* Group During *Sale Period*:									
C. First Item: TS+ First x TS	-0.014	0.019	-0.020*	-0.010	-0.001	-0.010*	-0.001	0.018	-0.007
	(0.008)	(0.028)	(0.011)	(0.006)	(0.013)	(0.005)	(0.006)	(0.026)	(0.008)

Item refers to the product category that appeared first in the email to the treatment group.All specifications include shopper, product category, and week fixed effects. Additional controls include: an indicator variable for whether or not this was a first item category, as well as this variable interacted with treatment, an indicator for a high rebate week (a rebate of $10 versus $2.99) as well as a control for the number of times this shopper purchased in this category during the pre-experiment period.

*Significant at 10%; **significant at 5%; ***significant at 1%

Table 9: Is the Sale Effect Different for Rebate Item Categories?

	Purchase Item in Category			Buy Target			Buy Substitue		
	All	**Same Line**	**Diff Line**	**All**	**Same Line**	**Diff Line**	**All**	**Same Line**	**Diff Line**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treat X Target Sale (TS)	0.014***	0.008	0.015***	0.004	-0.001	0.004	0.010**	0.007	0.011**
	(0.005)	(0.015)	(0.006)	(0.004)	(0.014)	(0.003)	(0.004)	(0.012)	(0.005)
Treat X TS X RebateItem	-0.005	0.007	-0.008	0.001	0.029*	-0.011	-0.004	-0.013	0.002
	(0.011)	(0.026)	(0.011)	(0.006)	(0.016)	(0.007)	(0.010)	(0.024)	(0.010)
Target Sale (TS)	-0.004	-0.001	-0.005	0.003	0.009	0.002	-0.007**	-0.008	-0.007**
	(0.004)	(0.010)	(0.004)	(0.003)	(0.011)	(0.002)	(0.003)	(0.011)	(0.004)
Rebate Item (RI) X (TS)	0.020***	0.013	0.018**	0.005	-0.012	0.011*	0.013**	0.020	0.006
	(0.007)	(0.016)	(0.007)	(0.005)	(0.011)	(0.006)	(0.006)	(0.019)	(0.006)
N ItemsxWeeks	20,215	5,122	15,093	20,215	5,122	15,093	20,215	5,122	15,093
Mean of Dependent	0.037	0.055	0.030	0.010	0.016	0.008	0.026	0.037	0.021
Variable:	[0.188]	[0.228]	[0.172]	[0.102]	[0.127]	[0.091]	[0.158]	[0.190]	[0.145]
Change in Purchase Rate of Treatment Group During Sale Period:									
TS+ Treat x TS	0.010**	0.007	0.009***	0.007**	0.008	0.006**	0.004	-0.001	0.004
	(0.004)	(0.011)	(0.003)	(0.003)	(0.009)	(0.002)	(0.003)	(0.007)	(0.003)
Rebate: TS+ Treat x TS +	0.025***	0.027	0.019**	0.013**	0.024***	0.006	0.013	0.006	0.012
RI x TS + Treat x TS X RI	(0.009)	(0.021)	(0.009)	(0.005)	(0.012)	(0.005)	(0.008)	(0.017)	(0.008)
Change in Purchase Rate of Control Group During Sale Period:									
Rebate: TS+ Treat x TS +	0.016**	0.012	0.013	0.008	-0.004	0.013*	0.007	0.012	-0.001
RI x TS + Treat x TS X RI	(0.008)	(0.018)	(0.008)	(0.006)	(0.011)	(0.006)	(0.006)	(0.020)	(0.007)

Standard errors are presented in parenthesis and clustered at the shopper level. Standard deviations are presented in brackets. An observation is defined by a shopper, week, and product category. For each shopper, we only include product categories where this shopper had a history of purchasing either the target or substitute item during the pre-experiment period. All specifications include shopper, product category, and week fixed effects. Rebate Item is equal to 1 if purchasing either the target or substitute item in that category resulted in a discount (rebate).Additional controls include: an indicator variable for a high rebate week (a rebate of $10 versus $2.99) as well as a control for the number of times this shopper purchased in this category during the pre-experiment period.
*Significant at 10%; **significant at 5%; ***significant at 1%

Table 10: Is the Sale Effect Different when the Treatment Group Received More Detailed Sale Information?

	Purchase Item in Category			Buy Target			Buy Substitue		
	All	**Same Line**	**Diff Line**	**All**	**Same Line**	**Diff Line**	**All**	**Same Line**	**Diff Line**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treat X Target Sale (TS)	0.020*	-0.033	0.039**	0.008	-0.006	0.007	0.013	-0.032	0.032***
	(0.012)	(0.031)	(0.015)	(0.007)	(0.017)	(0.011)	(0.009)	(0.021)	(0.011)
Treat X TS X Detail	-0.011	0.048	-0.032*	-0.006	0.009	-0.006	-0.004	0.046	-0.025*
	(0.014)	(0.035)	(0.019)	(0.010)	(0.016)	(0.013)	(0.012)	(0.030)	(0.015)
Target Sale (TS)	0.0005	0.033	-0.015	-0.001	0.013	-0.002	0.002	0.023	-0.012
	(0.008)	(0.021)	(0.011)	(0.005)	(0.012)	(0.007)	(0.007)	(0.016)	(0.008)
Detail X Target Sale (TS)	0.001	-0.034	0.016	0.008	-0.002	0.008	-0.009	-0.035*	0.005
	(0.011)	(0.022)	(0.016)	(0.007)	(0.013)	(0.009)	(0.010)	(0.019)	(0.012)
N ItemsxWeeks	14,443	4,537	9,906	14,443	4,537	9,906	14,443	4,537	9,906
Mean of Dependent Variable:	0.036 [0.187]	0.050 [0.218]	0.030 [0.170]	0.011 [0.104]	0.016 [0.125]	0.009 [0.093]	0.025 [0.156]	0.034 [0.181]	0.021 [0.143]
Change in Purchase Rate of *Treatment* Group During *Sale Period*:									
A. Non-Detail: TS+ Treat x TS	0.020**	-0.001	0.024*	0.007	0.008	0.005	0.015**	-0.009	0.020**
	(0.009)	(0.02)	(0.013)	(0.006)	(0.013)	(0.011)	(0.006)	(0.017)	(0.008)
B. Detail: TS+ Treat x TS + Detail x TS + Treat x TS x D	0.009	0.013	0.007	0.009*	0.015	0.007	0.002	0.002	0.001
	(0.008)	(0.018)	(0.008)	(0.005)	(0.012)	(0.005)	(0.005)	(0.014)	(0.005)
Change in Purchase Rate of *Control* Group During *Sale Period*:									
C. Detail: TS+ DetailxTS	0.001	-0.001	0.001	0.007*	0.011	0.006	-0.007	-0.012	-0.007
	(0.006)	(0.012)	(0.008)	(0.004)	(0.01)	(0.004)	(0.005)	(0.01)	(0.006)

product category. Detail refers to weeks where the treatment email specifically mentioned that some organic items are on sale. This analysis is run on a subset of 20 out of 28 of the product categories for which the target item is organic. All specifications include shopper, product category, and week fixed effects. Additional controls include: an indicator variable for whether or not this was a detailed email week, as well as this variable interacted with treatment, an indicator for a high rebate week (a rebate of $10 versus $2.99) as well as a control for the number of times this shopper purchased in this category during the pre-experiment period.
*Significant at 10%; **significant at 5%; ***significant at 1%

9 Appendix A: Estimating the Impact of a Sale on Shoppers

Our preferred specification (Table 6) includes all shoppers in the analysis (even if they did not make a purchase in that week). If different sales draw different types of consumers to shop on the site, then excluding non-shoppers could introduce selection bias into our results. Table 11 illustrates that our results are robust to excluding shoppers who did not make a purchase on the site during that week.

Table 11: The Effect of a Sale on Shoppers

	Baseline			Controlling for Information		
	Category	**Target**	**Substitute**	**Category**	**Target**	**Substitute**
	(1)	(2)	(3)	(4)	(5)	(6)
Target Sale (TS)	0.017***	0.014***	0.003	0.022**	0.014**	0.008
	(0.006)	(0.004)	(0.005)	(0.009)	(0.006)	(0.005)
Target Sale X History	0.026	0.040**	-0.009	-0.031	0.026	-0.051*
	(0.022)	(0.016)	(0.018)	(0.034)	(0.029)	(0.026)
History of Purchase	0.262***	0.051***	0.202***	0.277***	0.059***	0.206***
in Category (0/1)	(0.020)	(0.009)	(0.020)	(0.029)	(0.013)	(0.027)
High Rebate Week	0.008	0.003	0.006	0.010	0.004	0.007
(0/1)	(0.013)	(0.009)	(0.010)	(0.013)	(0.009)	(0.010)
Target Sale X Treat				-0.009	-0.000	-0.010
				(0.012)	(0.008)	(0.009)
Target Sale X Treat X Hist				0.110**	0.026	0.079**
				(0.043)	(0.034)	(0.036)
Treat X Hist				-0.031	-0.017	-0.010
				(0.038)	(0.018)	(0.039)
Item Category FE's	X	X	X	X	X	X
Shopper & Week FE's	X	X	X	X	X	X
N ItemsxWeeks	9,240	9,240	9,240	9,240	9,240	9,240
Mean of Dependent	0.110	0.033	0.075	0.110	0.033	0.075
Variable:	[0.313]	[0.178]	[0.263]	[0.313]	[0.178]	[0.263]
A. Change in Purchase Rate of Treatment Group with History During Sale Period:						
TS + TSxHistory				0.091***	0.067***	0.026
+ TSxTreat + TSxTreatxHist				(0.027)	(0.018)	(0.024)
B. Change in Purchase Rate of Control Group with History During Sale Period:						
TS + TSxHistory				-0.009	0.040	-0.043*
				(0.033)	(0.030)	(0.026)

Standard errors are presented in parenthesis and clustered at the shopper level. Standard deviations appear in brackets. An observation is defined by a shopper, week, and item category. History of Purchase is equal to 1 if the shopper purchased either a substitute or target item in this category in the pre experiment period. A high rebate week refers to weeks when the rebate was $10 for purchasing the rebate item.
High rebate week=0 when the rebate was $2.99.
*Significant at 10%; **significant at 5%; ***significant at 1%